

Amendments to the Claims

1. (Currently Amended): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane without depositing any material onto the exposed oxide-containing surface during any of said treating; and

after said treating with at least one of the borane or the silane without depositing any material onto the exposed oxide-containing surface during any of said treating, then forming a second capacitor electrode over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.

2. (Original): The method of claim 1 wherein the first capacitor electrode consists essentially of semiconductive material.

3. (Original): The method of claim 1 wherein the first capacitor electrode consists essentially of metal.

4. (Previously Presented): The method of claim 1 wherein the exposed oxide-containing surface comprises hafnium oxide.

5. (Previously Presented): The method of claim 1 wherein the exposed oxide-containing surface comprises aluminum oxide.

6. (Original): The method of claim 1 wherein the treating is with at least one borane.

7. (Original): The method of claim 6 wherein all borane used during the treating is void of halogen.

8. (Original): The method of claim 6 wherein the borane is selected from the group consisting of BH_3 , B_2H_6 , B_4H_{10} , B_5H_9 , B_6H_{10} and $\text{B}_{10}\text{H}_{14}$, and mixtures thereof.

9. (Original): The method of claim 1 wherein the treating is with at least one silane.

10. (Original): The method of claim 9 wherein all silane used during the treating is void of halogen.

11. (Original): The method of claim 9 wherein the silane is selected from the group consisting of SiH₄, Si₂H₆, Si₃H₈ and Si₄H₁₀, and mixtures thereof.

Claims 12-15 (Canceled).

16. (Original): The method of claim 1 wherein the treating comprises a temperature from 200°C to 500°C, and a pressure from 1 Torr to 100 Torr.

17. (Original): The method of claim 1 wherein the treating is for at least 1 second.

18. (Original): The method of claim 1 wherein the treating is for at least 10 seconds.

19. (Original): The method of claim 1 wherein the inner metal surface comprises an elemental metal or an alloy of elemental metals.

20. (Original): The method of claim 19 wherein the inner metal surface comprises tungsten.

21. (Original): The method of claim 1 wherein the inner metal surface comprises a conductive metal compound.

22. (Original): The method of claim 21 wherein the inner metal surface comprises TiN.

23. (Original): The method of claim 1 wherein the second capacitor electrode consists essentially of metal.

24. (Original): The method of claim 1 wherein the treating is effective to reduce leakage current of the capacitor than would otherwise occur in the absence of said treating.

25. (Previously Presented): The method of claim 1 wherein the exposed oxide-containing surface comprises OH groups, the treating being effective to passivate said OH groups.

26. (Previously Presented): The method of claim 1 wherein the depositing the second capacitor electrode comprises using a halogen-containing gas, the treating being effective to reduce halogen incorporation into the capacitor dielectric region than would otherwise occur in the absence of said treating.

27. (Previously Presented): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane;

forming a second capacitor electrode over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface;

wherein forming the capacitor dielectric region comprises deposition of multiple dielectric layers; and

intermediate at least some of the dielectric layer depositions, treating an outer surface of the capacitor dielectric region being formed with at least one of the borane or the silane.

28. (Original): The method of claim 27 wherein the treating is with at least one borane.

29. (Original): The method of claim 27 wherein the treating is with at least one silane.

30. (Original): The method of claim 27 wherein the multiple dielectric layers comprise at least two different dielectric materials.

31. (Original): The method of claim 27 wherein the multiple dielectric layers are of the same dielectric material.

32. (Original): The method of claim 1 wherein the first capacitor electrode consists essentially of semiconductive material and the second capacitor electrode consists essentially of metal thereby forming an MIS capacitor.

33. (Original): The method of claim 1 wherein the first capacitor electrode consists essentially of metal and the second capacitor electrode consists essentially of metal thereby forming an MIM capacitor.

34. (Currently Amended): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second, the treating being void of depositing any material onto the exposed oxide-containing surface during any of said treating; and

after said treating with at least one of the borane or the silane which is void of depositing any material onto the exposed oxide-containing surface during any of said treating, then forming a second capacitor electrode consisting essentially of metal over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.

35. (Previously Presented): The method of claim 34 wherein the exposed oxide-containing surface comprises hafnium oxide.

36. (Previously Presented): The method of claim 34 wherein the exposed oxide-containing surface comprises aluminum oxide.

37. (Original): The method of claim 34 wherein the treating is with at least one borane.

38. (Original): The method of claim 37 wherein all borane used during the treating is void of halogen.

39. (Original): The method of claim 37 wherein the borane is selected from the group consisting of BH_3 , B_2H_6 , B_4H_{10} , B_5H_9 , B_6H_{10} and $B_{10}H_{14}$, and mixtures thereof.

40. (Original): The method of claim 34 wherein the treating is with at least one silane.

41. (Original): The method of claim 40 wherein all silane used during the treating is void of halogen.

42. (Original): The method of claim 40 wherein the silane is selected from the group consisting of SiH_4 , Si_2H_6 , Si_3H_8 and Si_4H_{10} , and mixtures thereof.

Claim 43 (Canceled).

44. (Original): The method of claim 34 wherein the treating is for at least 10 seconds.

45. (Original): The method of claim 34 wherein the inner metal surface comprises an elemental metal or an alloy of elemental metals.

46. (Original): The method of claim 45 wherein the inner metal surface comprises tungsten.

47. (Original): The method of claim 34 wherein the inner metal surface comprises a conductive metal compound.

48. (Original): The method of claim 47 wherein the inner metal surface comprises TiN.

49. (Original): The method of claim 34 wherein the treating is effective to reduce leakage current of the capacitor than would otherwise occur in the absence of said treating.

50. (Previously Presented): The method of claim 34 wherein the exposed oxide-containing surface comprises OH groups, the treating being effective to passivate said OH groups.

51. (Previously Presented): The method of claim 34 wherein the depositing the second capacitor electrode comprises using a halogen-containing gas, the treating being effective to reduce halogen incorporation into the capacitor dielectric region than would otherwise occur in the absence of said treating.

52. (Previously Presented): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second;

forming a second capacitor electrode consisting essentially of metal over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface;

wherein forming the capacitor dielectric region comprises deposition of multiple dielectric layers; and

intermediate at least some of the dielectric layer depositions, treating an outer surface of the capacitor dielectric region being formed with at least one of the borane or the silane.

53. (Original): The method of claim 52 wherein the multiple dielectric layers comprise at least two different dielectric materials.

54. (Original): The method of claim 52 wherein the multiple dielectric layers are of the same dielectric material.

Claims 55-98 (Canceled).

99. (Currently Amended): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate, the first capacitor electrode comprising an exposed metal surface;

treating the exposed metal surface of the first capacitor electrode with at least one of a borane or a silane;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an oxide-containing surface received contacting against the treated metal surface of the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane without depositing any material onto the exposed oxide-containing surface during any of said treating; and

after said treating with at least one of the borane or the silane without depositing any material onto the exposed oxide-containing surface during any of said treating, then forming a second capacitor electrode over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.

100. (Currently Amended): A method of forming a capacitor, comprising:

forming a first capacitor electrode consisting essentially of metal over a semiconductor substrate, the first capacitor electrode comprising an exposed metal surface;

treating the exposed metal surface of the first capacitor electrode with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an oxide-containing surface received contacting against the treated metal surface of the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second, the treating being void of depositing any material onto the exposed oxide-containing surface during any of said treating; and

after said treating with at least one of the borane or the silane which is void of depositing any material onto the exposed oxide-containing surface during any of said treating, then forming a second capacitor electrode consisting essentially of metal over the treated oxide-containing surface, the

second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.

101. (Withdrawn): A method of forming a capacitor, comprising:
 - forming a first capacitor electrode over a semiconductor substrate, the first capacitor electrode comprising an exposed metal surface;
 - treating the exposed metal surface of the first capacitor electrode with at least one of a borane or a silane;
 - forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an oxide-containing surface received contacting against the treated metal surface of the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;
 - treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane, said treating depositing a material onto the exposed oxide-containing surface, said material being of a thickness of only three monolayers or less; and
 - forming a second capacitor electrode onto the material, the second capacitor electrode comprising an inner metal surface contacting against the material.

102. (Withdrawn): A method of forming a capacitor, comprising:

forming a first capacitor electrode consisting essentially of metal over a semiconductor substrate, the first capacitor electrode comprising an exposed metal surface;

treating the exposed metal surface of the first capacitor electrode with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an oxide-containing surface received contacting against the treated metal surface of the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second, said treating depositing a material onto the exposed oxide-containing surface, said material being of a thickness of only three monolayers or less; and

forming a second capacitor electrode consisting essentially of metal onto the material, the second capacitor electrode comprising an inner metal surface contacting against the material.

103. (Withdrawn): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed oxide-containing
surface;
treating the exposed oxide-containing surface of the capacitor
dielectric region with at least one of a borane or a silane, said treating
depositing a material onto the exposed oxide-containing surface, said
material being of a thickness of only three monolayers or less; and
forming a second capacitor electrode onto the material, the second
capacitor electrode comprising an inner metal surface contacting against the
material.

104. (Withdrawn): The method of claim 103 wherein the exposed
oxide-containing surface comprises hafnium oxide.

105. (Withdrawn): The method of claim 103 wherein the exposed
oxide-containing surface comprises aluminum oxide.

106. (Withdrawn): The method of claim 103 wherein the treating
is with at least one borane.

107. (Withdrawn): The method of claim 103 wherein the treating is with at least one silane.

108. (Withdrawn): The method of claim 103 wherein the treating is effective to reduce leakage current of the capacitor than would otherwise occur in the absence of said treating.

109. (Withdrawn): The method of claim 103 wherein the exposed oxide-containing surface comprises OH groups, the treating being effective to passivate said OH groups.

110. (Withdrawn): The method of claim 103 wherein the depositing the second capacitor electrode comprises using a halogen-containing gas, the treating being effective to reduce halogen incorporation into the capacitor dielectric region than would otherwise occur in the absence of said treating.

111. (Withdrawn): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed oxide-containing
surface;

treating the exposed oxide-containing surface of the capacitor
dielectric region with at least one of a borane or a silane at a temperature
from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at
least 1 second, said treating depositing a material onto the exposed oxide-
containing surface, said material being of a thickness of only three
monolayers or less; and

forming a second capacitor electrode consisting essentially of metal
onto the material, the second capacitor electrode comprising an inner metal
surface contacting against the material.

112. (Withdrawn): The method of claim 111 wherein the exposed
oxide-containing surface comprises hafnium oxide.

113. (Withdrawn): The method of claim 111 wherein the exposed
oxide-containing surface comprises aluminum oxide.

114. (Withdrawn): The method of claim 111 wherein the treating
is with at least one borane.

115. (Withdrawn): The method of claim 111 wherein the treating is with at least one silane.

116. (Withdrawn): The method of claim 111 wherein the treating is effective to reduce leakage current of the capacitor than would otherwise occur in the absence of said treating.

117. (Withdrawn): The method of claim 111 wherein the exposed oxide-containing surface comprises OH groups, the treating being effective to passivate said OH groups.

118. (Withdrawn): The method of claim 111 wherein the depositing the second capacitor electrode comprises using a halogen-containing gas, the treating being effective to reduce halogen incorporation into the capacitor dielectric region than would otherwise occur in the absence of said treating.

119. (Withdrawn): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed hafnium oxide-
containing surface;
treating the exposed hafnium oxide-containing surface of the capacitor
dielectric region with at least one of a borane or a silane; and
forming a second capacitor electrode over the treated hafnium oxide-
containing surface, the second capacitor electrode comprising an inner
metal surface contacting against the treated hafnium oxide-containing
surface.

120. (Withdrawn): The method of claim 119 wherein the treating
is with at least one borane.

121. (Withdrawn): The method of claim 119 wherein the treating
is with at least one silane.

122. (Withdrawn): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed aluminum oxide-
containing surface;
treating the exposed aluminum oxide-containing surface of the
capacitor dielectric region with at least one of a borane or a silane; and
forming a second capacitor electrode over the treated aluminum oxide-
containing surface, the second capacitor electrode comprising an inner
metal surface contacting against the treated aluminum oxide-containing
surface.

123. (Withdrawn): The method of claim 122 wherein the treating
is with at least one borane.

124. (Withdrawn): The method of claim 122 wherein the treating
is with at least one silane.

125. (Withdrawn): The method of claim 1 wherein the treating is
with at least one borane and with at least one silane.

126. (Withdrawn): The method of claim 34 wherein the treating is
with at least one borane and with at least one silane.

127. (Withdrawn): The method of claim 103 wherein the treating is with at least one borane and with at least one silane.

128. (Withdrawn): The method of claim 111 wherein the treating is with at least one borane and with at least one silane.

129. (Withdrawn): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;
treating the exposed oxide-containing surface of the capacitor dielectric region with at least one borane and with at least one silane; and
forming a second capacitor electrode over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.